CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A pixel cell comprising:

a first photo-conversion device that generates charge;

a second photo-conversion device that generates charge; and

readout circuitry that provides first readout signals indicating charge generated by the first device and second readout signals indicating charge generated by the second device.

2. The pixel cell of claim 1, wherein the first photo-conversion device is a pinned photodiode..

3. The pixel cell of claim 1, wherein the first photo-conversion device is one of an np photodiode, a pnp photodiode, an npn photodiode, a photogate, and a photoconductor.

4. The pixel cell of claim 1, wherein the second photo-conversion device is a floating diffusion region.

5. The pixel cell of claim 1, wherein the second photo-conversion device is a pinned photodiode.

6. The pixel cell of claim 5, wherein the first photo-conversion device is a pinned photodiode, and wherein the second photo-conversion device has a higher pinning voltage than the first photo-conversion device.

7. The pixel cell of claim 1, wherein the second photo-conversion device is one of an np photodiode, a pnp photodiode, an npn photodiode, a photogate, and a photoconductor.

8. The pixel cell of claim 1, further comprising a transistor having a gate adjacent to the first photo-conversion device, wherein the first transistor is one of a shutter transistor for determining an integration time or a transfer transistor for transferring photo-generated charge to the second photo-conversion device.

9. The pixel cell of claim 8, wherein the second photo-conversion device is adjacent to the transistor gate and on a side of the transistor gate opposite to the first photo-conversion device.

10. The pixel cell of claim 8, further comprising a doped well in the substrate below the transistor gate.

11. The pixel cell of claim 1, further comprising at least one doped well in the substrate.

12. The pixel cell of claim 11, wherein the second photo-conversion device is in the doped well.

13. The pixel cell of claim 11, wherein the first photo-conversion device is not in the doped well.

14. The pixel cell of claim 11, wherein the second photo-conversion device is not in the doped well.

15. The pixel cell of claim 14, wherein there is a doped well between the first and second photo-conversion devices.

16. The pixel cell of claim 1, further comprising a gate of transistor electrically connected to the second photo-conversion device, wherein the transistor is an output source follower transistor.

17. A pixel cell comprising:

a first gate structure that controls an output signal;

a first region of a substrate that is doped to generate charge in response to light, wherein the first region is electrically connected to the first gate structure;

a second region of the substrate that is doped to generate charge in response to light;

a second gate structure that controls charge transfer between the second and first regions.

18. The pixel cell of claim 17, wherein at least one of the first and second regions is a pinned photodiode.

19. The pixel cell of claim 17, wherein the first region is a doped region of a second conductivity type.

20. The pixel cell of claim 17, wherein the second gate structure is one of a shutter transistor for determining an integration time or a transfer transistor for transferring photo-generated charge to the first region.

21. The pixel cell of claim 17, further comprising a doped well of a first conductivity type in the substrate, wherein the first region is formed in the doped well.

22. The pixel cell of claim 17, wherein the first region is adjacent to the second gate structure and on a side of the second gate structure opposite to the first region.

23. A pixel cell comprising:

a pinned photodiode that generates charge in response to light;

a doped region of a substrate that generates charge in response to light and receives charge transferred from the pinned photodiode; and

a second gate of a second transistor electrically connected to the doped region.

24. A pixel cell comprising:

a first pinned photodiode that generates charge in response to light;

a first gate of a first transistor adjacent to the first pinned photodiode;

a second pinned photodiode that generates charge in response to light and receiving charge transferred from the first pinned photodiode; and

a second gate of a second transistor electrically connected to the second pinned photodiode.

25. An image sensor comprising:

an array of pixel cells, wherein at least two pixel cells each comprise:

a first photo-conversion device for generating charge;

a second photo-conversion device for generating charge; and

readout circuitry that provides first readout signals indicating charge generated by the first photo-conversion device and second readout signals indicating charge generated by the second photo-conversion device.

26. The image sensor of claim 25, wherein the first photo-conversion device is one of an np photodiode, a pnp photodiode, an npn photodiode, a photogate, and a photoconductor.

27. The image sensor of claim 25, wherein the second photo-conversion device is one of an np photodiode, a pnp photodiode, an npn photodiode, a photogate, and a photoconductor.

28. The image sensor of claim 25, wherein the first photo-conversion device is a pinned photodiode.

29. The image sensor of claim 25, wherein the second photo-conversion device is a floating diffusion region.

30. The image sensor of claim 25, wherein the second photo-conversion device is a pinned photodiode.

31. The image sensor of claim 30, wherein the first photo-conversion device is a pinned photodiode, and wherein the second photo-conversion device has a higher pinning voltage than the first photo-conversion device.

32. The image sensor of claim 25, further comprising a gate of a transistor adjacent to the first photo-conversion device, wherein the transistor is one of a shutter transistor for determining an integration time or a transfer transistor for transferring photo-generated charge to the second photo-conversion device.

33. The image sensor of claim 32, wherein the second photo-conversion device is adjacent to the transistor gate and on a side of the transistor gate opposite to the first photo-conversion device.

34. The image sensor of claim 32, further comprising a doped well in the substrate below the transistor gate.

35. The image sensor of claim 25, further comprising at least one doped well in the substrate.

36. The image sensor of claim 35, wherein the second photo-conversion device is in the doped well.

37. The image sensor of claim 35, wherein the first photo-conversion device is not in the doped well.

38. The image sensor of claim 35, wherein the second photo-conversion device is not in the doped well.

39. The image sensor of claim 38, wherein there is a doped well between the first and second photo-conversion devices.

40. The image sensor of claim 25, wherein the at least two pixel cells further comprise a gate of a transistor electrically connected to the second photo-conversion device, wherein the transistor is an output source follower transistor.

41. The image sensor of claim 25, further comprising control circuitry that applies a criterion to readout signals from the second photo-conversion devices until the criterion is met, and when the criterion is met, causes the readout circuitry to provide signals indicating charge generated by the first photo-conversion devices.

42. The image sensor of claim 25, further comprising correlated double sampling (CDS) circuitry that performs CDS operations.

43. An array of pixel cells comprising:

a plurality of pixel cells, wherein at least two pixel cells each comprise:

a first gate structure that controls an output signal;

a first region of a substrate that is doped to generate charge in response to light, wherein the first region is electrically connected to the first gate structure;

a second region of a substrate that is doped to generate charge in response to light;

a second gate structure that controls charge transfer between the second and first regions.

44. A processor system, comprising:

a processor;

an image sensor coupled to the processor, the image sensor comprising an array of pixel cells, wherein at least two of the pixel cells each comprise:

a first photo-conversion device that generates charge;

a second photo-conversion device that generates charge; and

readout circuitry that provides first readout signals indicating charge generated by the first photo-conversion device and second readout signals indicating charge generated by the second photo-conversion device; and

control circuitry that applies a criterion to readout signals from the second photo-conversion devices until the criterion is met, and when the criterion is met, causes the readout circuitry to provide signals indicating charge generated by the first photo-conversion devices.

45. The processor system of claim 44, wherein the image sensor further comprises correlated double sampling (CDS) circuitry that performs CDS operations.

46. An integrated circuit comprising:

a substrate;

an array of pixel cells at a surface of the substrate, wherein at least one of the pixel cells comprises a first photo-conversion device that generates charge, a second photo-conversion device that generates charge, and readout circuitry that provides first readout signals indicating charge generated by the first photo-conversion device and second readout signals indicating charge generated by the second photo-conversion device; and

control circuitry that applies a criterion to readout signals from the second photo-conversion devices until the criterion is met, and when the criterion is met, causes the readout circuitry to provide signals indicating charge generated by the first photo-conversion devices.

47. The integrated circuit of claim 46, further comprising correlated double sampling (CDS) circuitry that performs CDS operations.

48. A method of forming a pixel cell, the method comprising:

forming a first photo-conversion device that generates charge;

forming a second photo-conversion device that generates charge; and

forming readout circuitry that provides first readout signals indicating charge generated by the first device and second readout signals indicating charge generated by the second device.

49. The method of claim 48, wherein the act of forming the first photo-conversion device comprises forming one of an np photodiode, a pnp photodiode, an npn photodiode, a photogate, and a photoconductor.

50. The method of claim 48, wherein the act of forming the second photo-conversion device comprises forming one of an np photodiode, a pnp photodiode, an npn photodiode, a photogate, and a photoconductor.

51. The method of claim 48, wherein the act of forming the first photo-conversion device comprises a pinned photodiode.

52. The method of claim 48, wherein the act of forming the second photo-conversion device comprises forming a floating diffusion region.

53. The method of claim 48, wherein the act of forming the second photo-conversion device comprises forming a pinned photodiode.

54. The method of claim 53, wherein the act of forming the first photo-conversion device comprises forming a pinned photodiode, and further comprising setting a pinning voltage for the second photo-conversion device higher than a pinning voltage for the first photo-conversion device.

55. The method of claim 48, further comprising forming a gate of a transistor adjacent to the first photo-conversion device, wherein the act of forming the transistor gate comprises forming the gate of one of a shutter transistor for determining an integration time or a transfer transistor for transferring photo-generated charge to the second photo-conversion device.

56. The method of claim 55, wherein the act of forming the second photo-conversion device comprises forming the second photo-conversion device adjacent to the transistor gate and on a side of the transistor gate opposite to the first photo-conversion device.

57. The method of claim 55, further comprising forming a doped well of a first conductivity type in the substrate below the transistor gate.

58. The method of claim 48, further comprising forming at least one doped well of a first conductivity type in the substrate.

59. The method of claim 58, wherein the act of forming the second photo-conversion device comprises forming the second photo-conversion device in the doped well.

60. The method of claim 58, wherein the act of forming the first photo-conversion device comprises forming the first photo-conversion device outside of the doped well.

61. The method of claim 58, wherein the act of forming the second photo-conversion device comprises forming the second photo-conversion device outside of the doped well.

62. The method of claim 58, wherein the act of forming the at least one doped well comprises forming a doped well between the first and second photo-conversion devices.

63. The method of claim 48, further comprising forming a gate of a transistor, the act of forming the transistor gate comprising forming the gate of an output source follower transistor electrically connected to the second photo-conversion device.

64. A method of operating a pixel cell that includes first and second photo-conversion devices, the method comprising:

generating charge in response to light by first and second photo-conversion devices; and

obtaining a readout signal representative of the amount of charge generated by the second photo-conversion device while the first photo-conversion device is generating charge.

65. The method of claim 64, wherein the act of obtaining a readout signal representative of the amount of charge generated by the second photo-conversion device comprises monitoring the amount of charge generated by the second photo-conversion device.

66. The method of claim 64, further comprising:

at a time for readout of the charge generated by the first photo-conversion device, resetting the second photo-conversion device to a predetermined voltage;

reading out the predetermined voltage;

transferring the charge generated by the first photo-conversion device to the second photo-conversion device by operating a gate of a transistor; and

reading out the charge generated by the first photo-conversion device from the second photo-conversion device.

67. A method of operating a pixel cell that includes first and second photo-conversion devices, the method comprising:

comparing a first readout signal from the first photo-conversion device with a reference voltage; and

based on the act of comparing, obtaining a second readout signal indicating light received by the second photo-conversion device.

68. A method of operating an image sensor, the method comprising:

generating charge in response to light within an array of pixel cells, at least two of the pixel cells each comprising first and second photo-conversion devices;

obtaining signals representative of the charge generated by the second photo-conversion devices;

applying a criterion to the signals;

determining when the criterion is met; and

reading out the charge generated by the first photo-conversion devices when the criterion is met.

69. The method of claim 68, wherein the act of applying the criterion comprises comparing the signals to a reference voltage, and wherein the act of determining when the criterion is met comprises determining when any one of the signals is approximately equal to the reference voltage.

70. The method of claim 68, wherein the act of applying the criterion comprises comparing the signals to a reference voltage, and wherein t he act of determining when the criterion is met comprises determining when an average value of the signals is approximately equal to the reference voltage.

71. The method of claim 68, wherein the plurality of pixel cells are part of an array, wherein the pixel cells are arranged in a plurality of columns and

rows, wherein the act of generating charge comprises generating charge by first and second photo-conversion devices within each pixel cell of at least two rows, and wherein the act of monitoring the charge accumulated by the second photo-conversion devices comprises monitoring the charge accumulated by the second photo-conversion devices of all pixel cells in the at least two rows.

72. The method of claim 68, wherein the act of reading out of the charge generated by the plurality of pixel cells comprises:

resetting all second photo-conversion devices to a predetermined voltage;

reading out the predetermined voltage from each second photo-conversion device;

transferring the charge accumulated by each first photo-conversion device to the second photo-conversion device within a same pixel cell by operating gates of transistors; and

reading out the charge accumulated by each first photo-conversion device from each second photo-conversion device.